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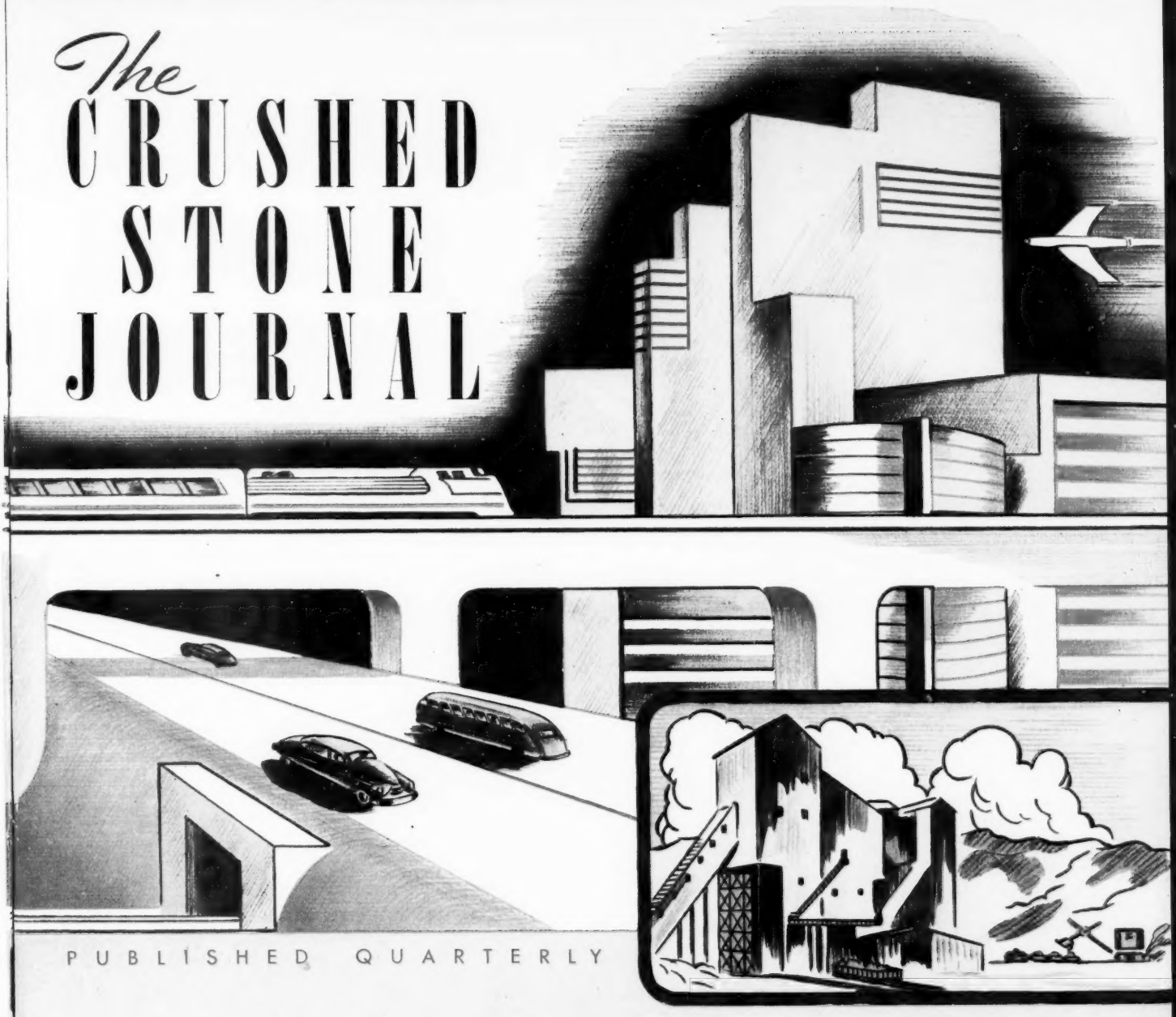

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- **Stone Sand for Use as Fine Aggregate**
- **"Depletion" in Federal Income Taxation of Mines**

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The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

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Stone Sand for Use as Fine Aggregate[1]

By A. T. GOLDBECK

Engineering Director
National Crushed Stone Association
Washington, D. C.

MANY a crushing and screening plant has been built on foundations made of concrete containing unprocessed stone screenings as the fine aggregate and those foundations, though perhaps a little rough in appearance, have served their purpose well. Stone sand, unlike stone screenings, is a specially prepared product, sometimes using stone screenings as the parent material and sometimes a coarser stone which is crushed to sand size with machines especially chosen because of their particular adaptability to stone sand production.

Qualities Desirable in Stone Sand

The fine aggregate in concrete, extending, in general, from the No. 4 or the No. 8 sieve down to dust, is necessary for the attainment of strength, density, economy, and workability, which involves ease of placement without segregation. The quantity of fine aggregate used, its gradation, and its particle shape, all have great effect on concrete workability. It should go without saying that resistance to freezing and thawing of stone sand, commonly referred to as durability, must be important in controlling the durability of concrete, and not only the quality of the parent rock but also the presence of deleterious materials such as shale or light, porous chert will affect the durability of stone sand. Lately other properties of aggregates have become recognized as having considerable effect on concrete durability, namely, thermal coefficient of expansion and pore size and volume.

[1] Presented at the National Crushed Stone Association Fourth Short Course for Salesmen, Washington, D. C., January 3, 1951.

It is the purpose of the present paper to discuss various matters regarding stone sand, briefly, but as definitely as the available facts will allow.

Stone Sand Production

Producers, because of different production and economic conditions in their localities, have different ideas as to how stone sand should be produced. These conditions are numerous and involve characteristics of the parent rock, price of competing sands, market for stone sand as compared with market for the fine sizes of stone for other uses, the specification requirements, cost of production using different methods, and many other considerations. It is little wonder, then, that we find different methods of production being used with a resulting variation in the product as far as shape of particle and gradation are concerned. A few typical examples will illustrate the principal production methods. These have been tabulated in the form of questions and answers in Table I.

Other schemes of production than those listed are also used, but the above are typical examples. Evidently Plants 1, 2, and 3 use screenings as the parent feed and no attempt is made at intermediate separation and recombination to obtain the most favorable gradation. In one case, Plant 1, a hammer mill is used together with a gyratory and Symons Cone. Parent screenings are generally so small in size that recrushing to a cubical particle shape would lead to a very small recovery of stone sand and much dust.

In Plants 4, 5, 6, 7, and 8, the feed is not screenings, but is of larger size, either 3/4 to 2 in., No. 4 to 1 in., minus 4 in., or minus 3/4 in. In these cases the sand must meet a rigid specification for shape of particle and consequently screenings cannot be used as the parent material.

As seen in Question 4, none of the plants listed attempts any intermediate separation process and yet the final gradations are generally acceptable. It should be pointed out, however, that some plants do use intermediate separation and recombination to the required gradation.

TABLE I
TYPICAL PRODUCTION METHODS

Plant No.	(1) Kind of Stone	(2) Size of Parent Rock	(3) Kind of Crusher Used for Making Stone Sand
1	Limestone	Primary & Secondary Screenings	Hammer Mill
2	Dolomite	Minus 1/8 & Minus 3/32 in.	Symons Cone
3	Trap Rock	Minus 1/8 in.	Symons Cone
4	Dolomite	Varies from 0 by 1/4 in. to 3/4 by 2 in.	A. C. Hammer Mill—no grates
5	Dolomite	No. 4 to 1 in.	Kent Mill
6	Dolomite	No. 4 to 1 in.	Two No. 2 Sturtevant Mills and one 5 by 10 ft. Rod Mill
7	Dolomitic Limestone	Minus 4 in. Minus 3/4 in.	Stedman (42 in.) Roll Crusher (16 by 36 in.)
8	Dolomite	Minus 2 in. plus 3/4 in.	Short Head Symons Cone crushing to minus 1/2 in. then to 24 by 54 in. rolls using heavy circulating load

Plant No.	(4) Product separated into size fractions for later recombination to desired gradation?	(6) If screens are not used what other separation process do you use?	(7) How are excess minus No. 100 fines eliminated?	(9) Any trouble with deficiency in certain sizes and how do you overcome that deficiency?
1	No	None—No. 8 sieve used for top size	1 Settling Tanks	Low on minus 50 mesh; remedied by reduced flow
2	No	None	2 Drag Washer followed by 2 Dorco Machines	Feed low on 30 to 80 mesh particles
3	No	None	3 Dorco Washer	Feed low on 30 to 80 mesh particles
4	No	None	4 Screen Classifier—wet	None
5	No	Over size only is screened by Weuse No. 6	5 Air Separator	Have trouble with No. 16 size when minus 200 is held to minus 5 per cent
6	No	Screens, Aero Vibe	6 Air Separator	Low in No. 16; top size reduced
7	No	All sand through a 0.102 in screen	7 Sand Drag	Runs to coarse side of No. 30 sieve
8	No	——	8 Sand Drag Classifier, 4 by 40 ft.	None

(10)
What in general is the gradation of sand produced?

Plant No.	1	2	3	4	5	6	7	8	Approx. Ave.
Size	Total Passing, per cent								
No. 4	100	100	100	100	100	100	100	100	100
No. 8	87	96	98	90-100	95-100	96	99	98	95
No. 16	72	69	64	50-75	55-65	65	68	65	66
No. 30	38	41	38	30-50	30-40	40	35	40	38
No. 50	15.5	20	18	10-30	15-25	25	20	20	20
No. 100	4.6	7	6	7-20	5-9	12	10	7	8
No. 200					0-5				5

Gradation of Stone Sand

The gradation of stone sand should be such as to produce maximum workability of concrete. At one time more material coarser than the No. 4 was used than is now thought advisable. It seems desirable to limit the amount of plus No. 8 material to 5 per cent. More fines, passing the No. 50 sieve are necessary for workability in stone sand than in rounded natural sands because angular stone sand does not pack to the same extent as rounded sand. Obviously, a high cement factor will permit of a coarser-graded sand than a low cement factor. Taking all things into consideration and based on experience and tests, the following gradation is suggested as being generally suitable for stone sand fine aggregate.

Sieves	Total Passing, per cent	Range
No. 4	100	100
No. 8	95	95-100
No. 16	70	60-75
No. 30	45	35-50
No. 50	20	15-25
No. 100	8	5-10
No. 200	5	3-6

Fineness modulus = 2.62

It will be observed that the average of the stone sands produced by the eight plants listed in Table I is within the size range listed above as being desirable.

Particle Shape

There can be no question that particle shape is very important in that it controls the workability of stone sand concrete. Shape of particle is not easy to define, but apparently the indirect method of measuring particle shape developed in the National Crushed Stone Association's laboratory some 12 years ago is very indicative and is sufficiently accurate for this purpose. Briefly, the method is based on the fact that when the sand is separated into its different size fractions, No. 8 to 16, 16 to 30, and 30 to 50, the more elongated and flatter the particle shapes, the higher will be the percentage of voids in these different size fractions.

The method consists of sieving the sand into these three sizes and testing each fraction for its voids as follows: The apparatus consists of a small cylinder, 2 7/8 in. in diameter (standard 3 in. tubing) and 5 1/2 in. high; a truncated cone-shaped funnel, having a large diameter of 5 1/2 in. and a small diameter of 1 in., is supported over the center of the cylinder so that the bottom of the funnel is 1 in. above the top of the cylinder.

The sample is placed in the funnel and, after filling, the sand is allowed to flow freely into the cylinder to overflowing. Without jarring, the excess is carefully struck off from the cylinder and the weight of the sand remaining in the cylinder is determined. An average of three determinations, having a maximum range of 4 grams, is used to calculate the voids. The bulk specific gravity of the sand is determined and the solid volume of the sand in the cylinder is then calculated. It is best to use the bulk specific gravity of the stone as determined on the coarse aggregate size when dealing with high-absorption material.

$$V = \frac{W}{G} \text{ where}$$

V = the solid volume in cc.
W = weight of sand in grams
G = the bulk specific gravity

$$\text{Per cent solid volume} = \frac{100V}{Vc} \text{ where}$$

Vc = volume of cylinder in cc.

The percentage of voids then equals 100 minus the percentage of solid volume.

Table II shows some typical results of voids determined as above, and likewise, in some cases, are listed the crushers used in preparing the sand, also some remarks as to the workability of concrete made with these respective sands.

Certainly the evidence is clearly in favor of a low void content, indicative of a cubical particle shape, for producing good workability in concrete. A percentage of voids of say 52 is desirable and 51 is still better; 53 is on the borderline of acceptability.

A Study of the Effect of Shape of Particle on the Mortar Making Properties of Stone Sand

A paper having the foregoing title appeared in the *Crushed Stone Journal*, March-April, 1938. The essential results of that study are worth repeating. Stone sand was prepared in three different ways from a sound limestone used in the local District of Columbia market. The natural sand used for comparison comes from the Potomac River.

The three methods for preparing the stone sand in the laboratory were selected because with them a wide range in particle shape could be obtained. The resulting sands are tabulated as "crushed," "ground," and "rounded." The "crushed" sand was prepared by crushing 1 1/2 to 2 in. stone in a small gyratory crusher having a 3/8 in. opening. This

TABLE II

SHAPE OF PARTICLE (Expressed as Per Cent Voids)

Lab. No.	Preparation	Specific Gravity	Av. Voids, per cent	Concrete Workability
35	Laboratory Gyratory Crusher	2.77	58.2	----
35	Laboratory Grinder	2.77	53.4	----
35	1 hour grinding with steel slugs	2.77	48.2	----
577	Commercial stone sand	2.72	51.2	----
633	Commercial stone sand	2.71	52.2	----
592	Commercial stone sand (large use in concrete)	2.84	52.9	----
1769	Commercial stone sand	2.73	51.7	----
1770	Commercial stone sand	2.73	51.3	----
1766	Unprocessed screenings	2.83	56.5	Very Poor
1771	Unprocessed screenings	2.98	54.3	Very Poor
2343	Rod Mill and Ring Mill	--	50.3	Excellent
2421	Hammer Mill, no grates	--	50.9	Excellent
2669	Unprocessed screenings	--	54.0	Poor
2674	Short head cone and rolls	--	51.7	Good
2671	Vertical Ring Roll	--	49.4	Excellent

product was quite slabby. The "ground" sand was prepared from the No. 4 to No. 50 material sieved from the crushed sand by passing it through a rotary grinder of the coffee-mill type. The "rounded" sand was prepared by first mixing equal portions of 3/8 in. to No. 4 material from the gyratory crusher with No. 4 to No. 50 material from the grinder. This mixture was ground in a small concrete mixer using a charge of steel slugs made from 2 in. lengths of steel reinforcing bars.

The average voids of the 4 to 8, 8 to 16, 16 to 30, and 30 to 50 mesh fractions were as follows:

Stone Sand:

Crushed	—	56 per cent
Ground	—	54 per cent
Rounded	—	47 per cent
Natural River Sand	—	46 per cent

The appearance of the various sands was in conformity with the indications of the voids test; the more angular the material, the higher the voids.

Mortar Tests

These various sands were made up into 5 different gradations as follows:

TABLE III

GRADATIONS OF SAND

No.	1	2	3	4	5
Size	Per Cent Passing				
No. 4	100.0	100.0	100.0	100.0	100.0
No. 8	92.5	92.5	94.0	95.0	96.0
No. 16	62.5	63.0	65.0	67.5	68.0
No. 30	37.5	39.0	41.0	43.5	45.0
No. 50	13.0	15.0	17.5	20.0	22.5
No. 100	3.0	6.5	10.0	12.5	15.0

The results of the tests of 1:2 by volume are as shown in Figure 1.

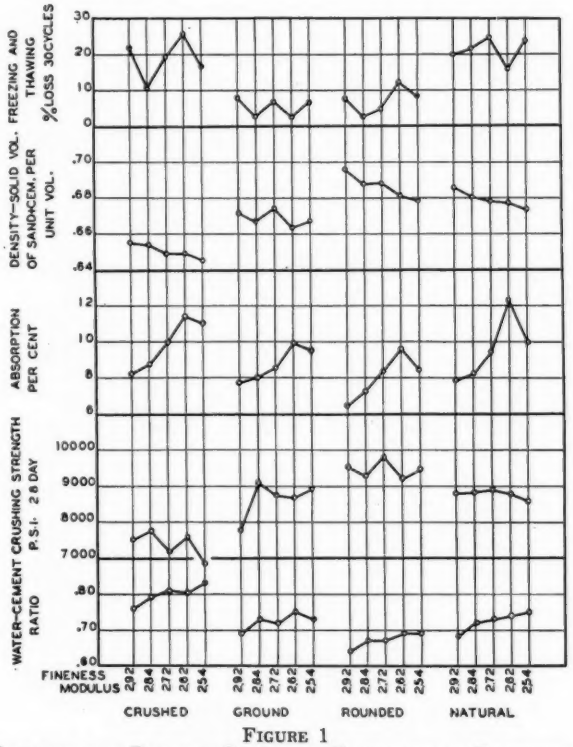

FIGURE 1

INFLUENCE OF PARTICLE SHAPE AND GRADATION ON PROPERTIES OF MORTARS

A study of these results will be valuable to stone producers. They show that a decided improvement can be made in stone sand, as to amount of mixing water required, as to density of mortar, crushing

strength, and durability under freezing and thawing, by improving the particle shape.

In commercial production, it seems best to use a feed larger than screenings, say from No. 4 to 1 or 2 in. and the best particle shape is obtained with the rod mill, some form of vertical ring roll, hammer mill and rolls with a heavy circulating load. The Corps of Engineers for its large dams has had good success with stone sand production, even with highly siliceous rocks, by wet grinding in a rod mill.

The preceding mortar tests have been followed by concrete tests, the essential data on which are given in Tables IV and V.

A study of the concrete results shows:

1. That the stone sand concrete in which the stone sand had been shaped reasonably well (per cent of voids, 52.5) seems to be equally as workable as the natural sand concrete. (Compare Mixes E and F)

2. That the water-cement ratio for the "ground" stone sand concrete is only slightly more than for the natural sand concrete; its compressive strength is only slightly less and its modulus of rupture is greater. (Mixes E and F)

3. When the stone sand is exceedingly flat and slabby (per cent of voids, 57.1) as in Mix B, the water-cement ratio is high, compressive strength is less than natural sand concrete, but its beam strength is about equal to that of the natural sand concrete. (Mixes B and E)

It is believed that these results are quite typical and it is evident that the shape of stone sand particle should not be neglected. These remarks apply to non-air-entraining concrete. When air entrainment is used, workability is improved, and suitable workability can frequently be obtained even with stone sand having relatively poor particle shape.

Effect of Air Entrainment on Durability of Stone Sand Concrete

It is remarkable what the purposeful entrainment of air will do in improving the durability of an otherwise non-durable stone sand concrete. Several cases of this kind have been investigated in our laboratory with similar results, so one illustration will suffice.

TABLE IV

GRADATION AND PARTICLE SHAPE OF SANDS USED IN CONCRETE TESTS

Identification	A	B	C	D	E	F
Sand	Potomac River	Limestone	Limestone	Limestone	Potomac River	Limestone
How Prepared	Natural	Crushed	Ground	Rounded	Natural	Ground
Shape, by per cent of voids	47.5	57.1	52.5	47.2	47.5	52.5
Gradation,						
Size	Total Passing, per cent					
No. 4	97	100	100	100	100	100
No. 8	82	97	97	97	97	85
No. 16	70	64	63	63	63	63
No. 30	52	41	41	41	41	43
No. 50	16	20	21	22	21	22
No. 100	3	6	6	6	5	7

TABLE V

CONCRETE TESTS

Identification	A	B	C	D	E	F
Sand	Potomac River	Limestone	Limestone	Limestone	Potomac River	Limestone
How Prepared	Natural	Crushed	Ground	Rounded	Natural	Ground
Shape, by per cent voids	47.5	57.1	52.5	47.2	47.5	52.5
	Data on Mixes					
Slump, in.	2 3/4	2 1/2	2 3/4	3	2 1/4	2 1/2
Flow	166	162	165	172	160	164
Cement factor, sacks per cu. yd.	5.88	5.89	5.91	5.90	5.89	5.91
Water-cement ratio	0.75	0.82	0.79	0.72	0.74	0.77
Modulus of rupture, 28 days	810	814	861	998	805	883
Compressive strength, 28 days	4620	4080	4460	4880	4650	4450

A particular limestone sand had given bad results in service and it was decided to determine if anything might be done to improve its performance. Air entrainment offered distinct possibilities. Without going into too much detail,[2] concrete was made with the stone sand in question and with the same limestone as the coarse aggregate. A constant cement factor of 6 sacks per cu. yd. was used in all mixes, which, however, were varied in their air content. A slump of about 2.5 in. was obtained in all mixes. The results are best expressed in the accompanying curves. (Figures 2 and 3)

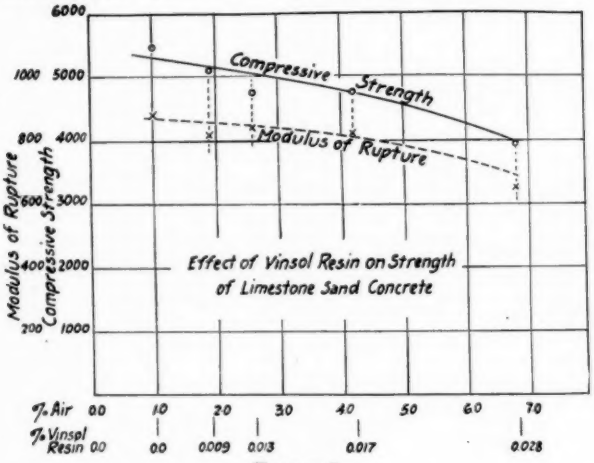

FIGURE 2
EFFECT OF VINSOL RESIN ON STRENGTH OF LIMESTONE SAND CONCRETE

A study of these curves will show:

1. That even as little as 2.1 per cent of purposefully entrained air effected an almost complete cure for the lack of durability in the non-air-entraining stone sand mix. (Compare 3A with 3B)

2. That the air reduced the compressive and beam strengths, but only to the extent of 13 per cent in compression and 8 per cent in modulus of rupture when 5 per cent of air was used.

Slipperiness of Stone Sand Concrete

No discussion of stone sand for use as a fine aggregate in concrete would be complete without some mention of its effect on the slipperiness of concrete pavements. In two of the states, Pennsylvania and Michigan, it has been found that certain limestone sand concretes have become unusually slippery. Actual tests in Michigan have proven this to be so as determined by the distance required to bring a

[2] See *Proceedings*, American Concrete Institute, 1946, p. 649.

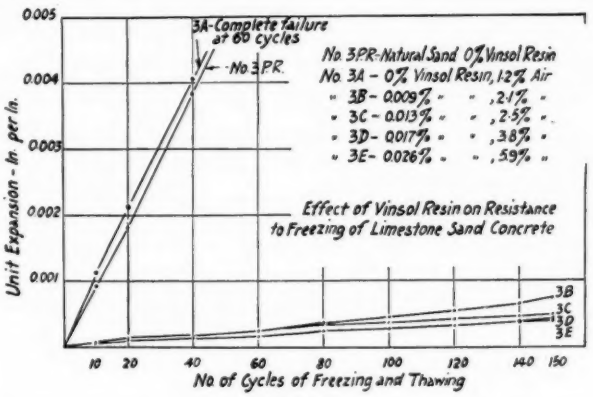
3A-Complete failure at 60 cycles
No. 3PR
No. 3PR-Natural Sand 0% Vinsol Resin
No. 3A - 0% Vinsol Resin, 1.2% Air
" 3B - 0.009% " " ,2.1% "
" 3C - 0.013% " " ,2.5% "
" 3D - 0.017% " " ,3.8% "
" 3E - 0.026% " " ,5.9% "
Effect of Vinsol Resin on Resistance to Freezing of Limestone Sand Concrete
Unit Expansion - In. per In.
No. of Cycles of Freezing and Thawing

FIGURE 3
EFFECT OF VINSOL RESIN ON RESISTANCE TO FREEZING OF LIMESTONE SAND CONCRETE

test vehicle to rest after hard application of the brakes. Probably this phenomenon has to do with the softness of the particular stones in question. The projecting points of sand wear off under traffic and a mosaic surface results which has no "tooth", unlike the case of hard, silicious sands in which the small projections persist. Prospective limestone sand producers should fully understand this situation, especially if they expect a big market in concrete pavement construction.

Thermal Compatibility

When there is a large difference between thermal coefficient of expansion of the mortar and of the coarse aggregate, it is thought, especially by the Corps of Engineers, that danger exists of more rapid failure of the concrete than when the mortar and coarse aggregate are more nearly alike in their thermal properties. Of 18 large dams built or being built by the Corps of Engineers, 13 have utilized stone sand fine aggregate because of its better thermal properties in combination with coarse aggregate from the same source and in part because of the better possibility of obtaining the most favorable gradation with stone sand or "manufactured" sand, as they term it, a matter of great importance in lean mass concrete for dams.

In conclusion, stone sand, well made, is an excellent fine aggregate for concrete. The proper method for its production should be investigated carefully so that the sand will have a favorable particle shape and a desirable gradation. When the parent material is sound and the sand is prepared correctly, very workable concrete having high strength and lasting durability can be produced.

"Depletion" in Federal Income Taxation of Mines*

By K. S. BENSON
Attorney
Pickands Mather and Co.
Cleveland, Ohio

DEPLETION is a subject of vital importance to the mining industry. Yet, in spite of its importance, its significance is not generally understood. The purpose of this discussion is to clarify the main aspects of the subject from the viewpoint of a metal mine taxpayer.

To define the term depletion, it is necessary to distinguish among its various uses. In the economic or geological sense, depletion means the exhaustion of a natural resource. A mineral deposit is a wasting asset and once exhausted is nonrenewable. Millions of years were needed to produce an ore deposit, which may be consumed in a few years and which cannot be replaced except by the discovery of new sources of supply. The wasting asset feature of the mining industry has a vital bearing on the impact of the Federal Income Tax Law on this industry. This is recognized in the law by the various provisions dealing with the depletion allowance, and in this sense the term depletion has an income tax meaning.

Depletion from Tax Viewpoint

Depletion from the tax viewpoint means the statutory deduction from gross income designed to permit the return to the taxpayer of the capital consumed in the production and sale of a natural resource. The mining enterprise realizes income on the extraction and sale of minerals and a portion of the income realized represents capital consumed. As the resource is exhausted, the mining enterprise approaches the end of its existence unless new sources of supply can be acquired. Depletion from the tax viewpoint is a creature of statute with limited meaning and application and, in essence, is a method for amortizing the value of the primary asset of a mining enterprise.

An example can best illustrate the significance of depletion from the tax viewpoint. Compare a manufacturing concern with a mining company. In computing taxable income of a manufacturing concern, consideration is given to the cost of producing such income, the principal costs being capital investment for plant and equipment, labor, and raw materials going into the products produced. A mining enterprise, on the other hand, is faced with a different problem because its principal asset is the natural resource which it is producing. In computing its taxable income, consideration is given also to its capital investment for plant and equipment and the cost of labor; but in addition, recognition must be given to the fact that a portion of the proceeds realized on the sale of mineral represents capital. Without such recognition, the mining company would be taxed not on income but on capital and income, and Congress has never intended that capital be taxed as income.

Methods for Determining Depletion Allowance

Thus, when depletion allowable is referred to in the mining industry, it means the statutory deduction allowable in computing taxable income of a mining enterprise. For guidance the appropriate provisions of the Internal Revenue Code, Income Tax Regulations, and the judicial decisions interpreting and construing them must be examined. It is important to identify and distinguish three methods of determining the allowance for depletion: 1—Cost depletion, 2—Discovery depletion, and 3—Percentage depletion. The basic method is cost depletion and in addition some taxpayers may be entitled to use discovery depletion and other taxpayers may be entitled to use percentage depletion. Discovery depletion and percentage depletion, however, are mutually exclusive and if a taxpayer is entitled to percentage depletion, he is not entitled to discovery depletion. By statute, a metal mine taxpayer is entitled to use cost depletion or percentage depletion, whichever produces the highest deduction. Thus, discovery depletion is merely of academic interest to such taxpayers and to most others.

* Reprinted from *Mining Engineering*.

Briefly and broadly speaking, these methods of determining depletion may be described as follows:

1—*Cost Depletion:* Under this method, the allowable deduction for depletion is based upon the cost of the particular deposit to the taxpayer, unless the deposit was owned prior to March 1, 1913, in which case the taxpayer may use the fair market value of the deposit on that date or actual cost, whichever is higher. This method is sometimes described as *basis depletion* or *adjusted basis depletion,* but in this discussion it will be referred to as *cost depletion.*

2—*Discovery Depletion:* Under this method, the allowable deduction for depletion is based on the fair market value of the deposit at the date of discovery or within 30 days thereafter and was originally designed to take into account deposits discovered subsequent to February 28, 1913.

3—*Percentage Depletion:* Under this method, the allowable deduction for depletion is based on a specified percentage of the income realized during the taxable year from a particular property.

As stated, the concept of depletion is based upon the exhaustion of a natural resource as distinguished, for example, from the concept of depreciation based on the exhaustion of property used in trade or business. From the tax viewpoint, depletion first became important in the administration of the Corporation Tax Act of 1909, which provided for an excise tax on net income. As soon as this act went into effect, mining taxpayers attempted to claim a deduction for depletion in computing net income although there was no specific mention of a deduction for depletion in the statute. The courts in these cases uniformly held that the statute did not permit an allowance for depletion in computing net income and also held that the provision permitting a reasonable allowance for depreciation did not include depletion. These early cases are quite significant because they establish the principle that the deduction for depletion is not a matter of right but of Congressional grace, and reference must be made to specific statutes to determine the scope of the depletion deduction.

As a result of the hardship to operators of mines, Congress in the first income tax law (the Revenue Act of 1913) provided for ". . . a reasonable allowance for the exhaustion, wear and tear of property arising out of its use or employment in the business, not to exceed, in the case of mines 5 per cent of the gross value at the mine of the output for the year for which the computation is made, . . .". The word *depletion* first made its appearance in the 1916 Revenue Act, which provided for a reasonable allowance for depletion in the case of mines not to exceed the market value in the mine of the product thereof mined and sold during the year for which the return and computation are made. The 1916 Act limited the deduction for depletion to the recovery of cost, or in the case of deposits acquired prior to March 1, 1913, to the fair market value as of that date. The principal change in the 1918 Revenue Act was the introduction for the first time of discovery depletion in the case of mines, oil, and gas wells discovered by the taxpayer on or after March 1, 1913, with the depletion allowance based upon the fair market value of the property at the date of discovery or within 30 days thereafter.

Essentially two methods of computing depletion had developed, namely, cost and discovery depletion. During the ensuing years, it became evident that the administration of both cost depletion and discovery depletion was too complex and many inequities were unavoidable, so that the remedy seemed to be the adoption by Congress of a different, simpler and fairer method of calculating the allowance for depletion. In the 1926 Revenue Act, Congress, in the case of oil and gas wells, adopted percentage depletion so as to permit the deduction for depletion to be based upon a percentage of gross income derived from the properties, limited to 50 per cent of the net income of the taxpayer from each property, and at the same time eliminated discovery depletion with respect to these items. In the 1932 Revenue Act, percentage depletion was extended to coal, metal mines and sulphur, and at the same time discovery depletion eliminated with respect to these items. Since that time, the benefits of percentage depletion have been extended to many other items.

This summarization, while not complete, points out the manner in which the methods of computing depletion have developed, and illustrates that once Congress recognized the concept of depletion for tax purposes the main problem was, and still is, the determination of the amount and method of computing the depletion deduction.

Depletion Provisions in Present Tax Law

Sections 23(m) and 114(b) of the present Internal Revenue Code relate to the allowance for depletion and reference must be made to these sections as well as to the regulations issued by the Commis-

sioner to determine the scope and application of the present depletion provisions. Section 23(m) provides, in computing net income, there shall be allowed as a deduction, "In the case of mines . . . a reasonable allowance for depletion and for depreciation of improvements, according to the peculiar conditions in each case; such reasonable allowance in all cases to be made under rules and regulations to be prescribed by the Commissioner, with the approval of the Secretary." Section 114(b) outlines the methods of calculating depletion and under this section of the Code a metal mine taxpayer may be entitled to a deduction for depletion based upon the cost method or upon the percentage method, whichever is higher.

Economic Interest Test Is Important

The language of Section 23(m) clearly points out that depletion is not restricted by the form of legal entity seeking depletion. Thus it is allowable to individuals, corporations, partnerships, trusts, etc., assuming, of course, that the other requirements of the Code and regulations are met. All taxpayers, however, who seek a deduction for depletion must be the owner of an economic interest in a mineral deposit. Treasury Regulation 111, Section 29.23(m)-1 defines an economic interest as being possessed, " . . . in every case in which the taxpayer has acquired, by investment, any interest in mineral in place . . . and secures, by any form of legal relationship, income derived from the severance and sale of the mineral . . . , to which he must look for a return of his capital. But a person who has no capital investment in the mineral deposit . . . does not possess an economic interest merely because, through a contractual relation to the owner, he possesses a mere economic advantage derived from production." This requirement that a taxpayer be the owner of an economic interest has caused much litigation, and the definition set forth in the regulation developed over a period of many years.

In addition to determining whether a taxpayer is eligible for the depletion allowance, the economic interest test is important in determining the tax consequence of certain transactions. For example, a taxpayer may claim that he has sold his interest in a mineral deposit to obtain a capital gain, but if he has retained an economic interest in the mineral, the payments received are ordinary income subject to depletion. On the other hand, a taxpayer may claim a deduction for depletion only to find that he has made a *sale* and thus no deduction for depletion is allowable. The allowance of depletion and the benefit of the capital gain provisions are mutually exclusive.

The test of economic interest has been, and still is, difficult to apply in determining whether or not the taxpayer is entitled to a deduction for depletion. At one extreme, it is clear that the sole owner and operator of a mineral property is entitled to depletion because he, of all persons, clearly has an economic interest in mineral in place. At the other extreme, a person who sells his interest in a mineral is not entitled to depletion because he has converted his economic interest in mineral in place into another form of capital. In between these two extremes, there are a myriad of transactions which fall on one side or the other.

1—*Royalty Payments:* In the usual lessor-lessee relationship, a mineral property is leased by the owner to an operator. The lessor receives a royalty rate from the lessee, and the lessee, realizes income from the production and sale of the mineral. Both the lessor and lessee have an economic interest and both are entitled to depletion. The lessor is entitled to depletion on income represented by royalty payments received, and the lessee is entitled to depletion on income realized on the extraction and sale of the mineral. It is immaterial whether the royalty is payable in mineral, or in a sum of money per unit extracted, or as a percentage of gross profits, or as a percentage of net profits. It should be noted, however, that when royalty is based upon a percentage of net profits some question may still be raised as to whether the lessor is entitled to depletion. For many years it was held by the courts that a share in the net profits from the development and operation of a mineral property does not entitle the holder of such an interest to a depletion allowance even though continued production is essential to the realization of such profits. In two recent cases involving oil leases (Kirby Petroleum Co. vs. Commissioner, 326 U. S. 599, and Burton-Sutton Oil Co., Inc. vs. Commissioner, 328 U. S. 25) the Supreme Court ruled that a lessor receiving a share of the net profits realized by the lessee from operations under a lease is entitled to depletion on such share of the net profits because this interest constitutes an *economic interest.* The rule of these decisions has been followed in other recent cases and it is probable that this rule will be applicable to other types of leases.

2—*Stock Interest:* A stock interest does not constitute an *economic interest* in mineral in place. Therefore, a stockholder of a mining company or an oil company receiving dividends is not entitled to depletion upon such dividends. However, in some instances if the company making the distribution does not have any earnings or profits but makes the distribution from reserves arising by reason of cost depletion, the dividend may be nontaxable as a return of capital. Likewise if a stockholder in a mining company or an oil company sells his stock under an arrangement whereby he is to share in the net profits from the development and operation of the property of the oil company or mining company, such taxpayer is not entitled to a depletion deduction against the payments received under this arrangement.

3—*Stripping Contracts:* Although it does not appear that any stripping contract cases have developed involving metal mines, the problem has arisen in the case of coal mines. The Commissioner has ruled that contractors who have undertaken to remove overburden and mine coal may, dependent upon their rights in respect of the properties involved, be entitled to the deduction for depletion as in the case of other mineral properties. The allowance is warranted only where under the agreement between the parties, the stripping contractor obtains a capital interest in the mineral in place and must look to severance and sale of the mineral for the return of capital consumed in the process. Thus, if the compensation of the contractor is, by the terms of the contract, to be derived solely from the sale of the coal, depletion is allowable. If, on the other hand, the compensation of the contractor is dependent entirely upon removal of the overburden and other services with no part of the compensation derived from the extraction and sale of the coal, the deduction for depletion is not allowable. In some cases, it may be necessary to split the income received by the contractor so that the income derived from the mining and sale of the coal would be subject to the depletion allowance.

4—*Cash Payments:* If a lease is sold for cash plus a royalty, the seller-lessor is entitled to depletion allowance on only that part of the income arising from the royalty payment. If, however, the cash payment is an advance royalty, and the presence of an overriding royalty usually makes the cash payment an advance royalty, depletion is allowable on not only the royalty income but on the cash payment income. In connection with advance royalty and minimum royalty, Treasury Regulation 111, Section 29.23(m)-10 prescribes a rule which may seriously affect a lessor. For example, if a lessor receives advance royalty or minimum royalty under the terms of a lease prior to production, he is entitled to a depletion allowance on such income in the year of receipt in accordance with the terms of the aforementioned regulation but if the mineral rights granted expire, terminate or are abandoned before the mineral which has been paid for in advance has been mined, the grantor must report in the year of such expiration, termination or abandonment income equal to the depletion deductions of prior years, and such prior deductions are restored to his capital account.

Problem of the Metal Mine Taxpayer

In addition to meeting the requirement of economic interest, the metal mine taxpayer must qualify as an operator of a *metal mine.* In this connection both the terms *metal* and *mine* have technical meanings. If low grade chromite ore is mined and pressed into refractory brick, no depletion is allowable because the mineral is not being used for a metal purpose. If the mineral, after mining, is processed into chromium metal, depletion would be allowable. Thus it is evident that the so-called *use test* can cause many complications. As to the meaning of the term *mine,* the best illustrations of the problem appear in the so-called tailings dump and lean ore cases that are becoming increasingly more important.

Income may be derived from reworking a tailings dump or from working a low grade ore dump, and this in turn raises the question of whether a deduction for depletion is allowable against such income. In the cases involving this point, the decisions have generally turned on whether a tailings dump or a lean ore dump is a mine within the meaning of Section 23(m). In the Kohinoor Coal Co. case (171 F. (2d) 880 (CCA 3rd)) it was held that the lessee of a culm or refuse bank, thrown aside by the owner-operator of a coal mine, was not entitled to percentage depletion, and this case followed the rule of Chicago Mines Co. vs. Commissioner (164 F. (2d) 785 (CCA 10th)) and Consolidated Chollar Gould & Savage Mining Co. (133 F. (2d) 440 (CCA 9th)). In this latter case, the taxpayer extracted ore from tailings dumps composed of broken ore bearing rock

taken from adjoining mines, and the court held that such extraction did not constitute operation of a mine and percentage depletions was not allowable. On the other hand, the Ninth Circuit Court of Appeals has held that a taxpayer is entitled to depletion on income derived from reworking a tailings dump previously created by him by processing ore from his mine (Commissioner vs. Kennedy Mining & Milling Co., 125 F. (2d) 399) and has also allowed depletion on income derived by a lessee of a mine from the treatment of tailings left by a previous operator (New Idria Quicksilver Mining Co. vs. Commissioner, 144 F. (2d) 918). While attempts have been made to distinguish these various cases, in all probability the question will never be free from doubt until ruled upon by the United States Supreme Court or until clarified by Congress.

Computing Depletion Allowance

There are several methods of computing the depletion allowance, assuming a taxpayer is entitled to the deduction for depletion. As previously pointed out, in computing the allowance for depletion, a metal mine taxpayer should make two calculations, namely, the depletion allowable by the cost method and depletion allowable by the percentage method because he is entitled to the greater deduction.

Cost Depletion: To determine the allowance for cost depletion in a particular year, the taxpayer must establish three factors: 1—The basis upon which the depletion allowance is to be computed, 2—The estimated total recoverable units of mineral in the property, 3—The number of units of mineral sold in the year. Expressed in another way, the taxpayer divides his adjusted basis for the property by the total remaining units of mineral in the property to obtain the depletion unit. Then he multiplies the depletion unit by the number of units of mineral mined and sold in the year in question.

There are many technical questions involved in the determination of the basis upon which depletion is to be allowed, and each taxpayer should read carefully the provisions of Section 113 of the Code, along with the pertinent Treasury Regulations and Court decisions. Simply stated, basis means a money value assigned to property for tax purposes, and in the case of cost depletion it is the money value assigned to a mineral property for the purpose of computing the depletion allowance. Normally this is cost unless the property was acquired prior to March 1, 1913, in which case it is cost or the fair market value of the property as of that date, whichever is higher, properly adjusted in accordance with the provisions of Section 113. Once the adjusted basis has been obtained, it normally is the basis for the entire property, and for depletion purposes this must be further adjusted so as to eliminate any cost or value of the land for purposes other than mineral production, to eliminate any amounts recoverable through depreciation and from deductions other than depletion, and to eliminate the residual values of such property at the end of the operation. Once the basis for depletion has been determined, it remains the same during the life of the property except that it is reduced by depletion deductions allowed and increased by allowable capital additions. On this latter point, Regulation 111, Section 29.23 (m)-15 provides that any expenditures in excess of net receipts for minerals sold shall be charged to the capital account recoverable through depletion while the mine is in the development stage. A mine is considered to have passed from a development to a producing status when the major portion of the mineral production is obtained from workings other than those opened for the purpose of development; or when the principal activity of the mine becomes the production of developed ore rather than the development of additional ore for mining. Thus, for example, in an open pit iron ore mine, the stripping cost prior to the time the mine becomes a producing mine is capitalized and recoverable through depletion, and the amount expended for this pre-production development would be an allowable capital addition to the basis for the calculation of cost depletion. After the mine reaches the producing stage, any stripping costs would be capitalized and deducted ratably against the production benefitted. Such deductions would be in addition to the allowance for depletion. On the other hand, whether in the pre-development or post-development stage, expenditures for plant and equipment and for replacements, not including expenditures for maintenance and ordinary and necessary repairs, shall ordinarily be charged to the capital account recoverable through depreciation.

After determining the basis for depletion, the next step is to determine the number of total recoverable units of the mineral in the deposit in the year in question. This involves an estimate on the basis of reasonably known facts at the time the estimate is made. The estimate is to be in accordance with

methods current in the industry and the problem is primarily an engineering one. In the event either the Commissioner or the taxpayer, as a result of operations or development work, determines that the total recoverable mineral units are either greater or less than the prior estimate, a revision thereof is made and the revised estimate is used in determining the depletion unit.

Once the basis and total estimated units of mineral have been determined the depletion unit can be arrived at, and this unit is then multiplied by the units of mineral mined and sold within the taxable year. A simple illustration will point out the mechanics of computing cost depletion, although in practice most computations are not quite as simple. It may be assumed that a taxpayer purchases the fee of a property for the sum of $480,000 and that this property has no value except for the mineral contained therein. The basis for the purpose of computing cost depletion will be the purchase price of $480,000. If pre-production development expenditures total $120,000, this amount is an allowable capital addition and will increase the basis to $600,000. Assuming that the property contains an estimated 2,000,000 tons of recoverable iron ore, the depletion unit will be 30 cents per ton and on the production and sale of 50,000 tons, the cost depletion allowable would be $15,000 for that year. In the following year, $15,000 would be subtracted from the original basis, leaving a remaining basis of $585,000. If the total recoverable units of mineral remain unchanged (except for the subtraction of prior year's production sold), the depletion unit will continue to be 30 cents per ton until the total basis is recovered. In the event a revision is made of the total estimated units of mineral, the depletion unit will be either larger or smaller depending upon the revised estimate, but in no event can more than the remaining basis of $585,000 be recovered by cost depletion, or an over-all total of $600,000 on the facts assumed.

Having calculated the allowance for cost depletion, the taxpayer should next compute the percentage depletion allowable.

Percentage Depletion: In the case of metal mines, the allowance for percentage depletion is 15 per cent of the gross income from the property during the taxable year, excluding from such gross income an amount equal to any rents or royalties paid or incurred by the taxpayer in respect to the property but such allowance cannot exceed 50 per cent of the net income of the taxpayer (computed without allowance for depletion) from the property. Thus, there are two limitations in the calculation of the percentage depletion allowance, and in some instances the allowance will be determined by the 50 per cent of net income limitation, and in other instances the 15 per cent of gross income limitation will govern. In view of these limitations, there has been much litigation because the Commissioner has attempted to minimize as much as possible *gross income* and *net income* in order to reduce the allowance. Most problems involving the calculation of percentage depletion center about the meaning of *gross income, net income* and *property.*

Gross income from the property in the case of a crude mineral product other than oil and gas is defined to mean the gross income from mining. The term *mining* includes not only the extraction of the ores or minerals from the ground, but also the ordinary treatment processes normally applied by mine owners or operators to obtain the commercially marketable mineral product or products and so much of the transportation of ores or minerals (whether or not by common carrier) from the point of extraction from the ground to the plants or mills in which the ordinary treatment processes are applied thereto as is not in excess of 50 miles. If the transportation to the plants or mills exceeds 50 miles, the Commissioner must approve the excess transportation if it is to be included in the definition of gross income from the property. In the case of iron ore, the ordinary treatment processes include sorting, concentrating and sintering to bring to shipping grade and form and loading for shipment. If the taxpayer sells his mineral product in the immediate vicinity of the mine, gross income would be the amount for which the product was sold. If, however, the product is transported or processed other than for ordinary treatment processes, gross income would be the representative market or field price without such transportation and processing. In the case of iron ore, for example, the gross income from the property would be the f.o.b. mine value realized by the taxpayer on shipments less any rents or royalties paid or incurred with respect to the property.

Net income of the taxpayer (computed without allowance for depletion) from the property means the gross income from the property less the allowable deductions attributable to the mineral property upon which the depletion is claimed and the allowable deductions attributable to ordinary treatment

processes insofar as they relate to the product of such property, including overhead and operating expenses, development costs properly charged to expense, depreciation, taxes, losses sustained, etc. but excluding any allowance for depletion. Deductions not directly attributable to a particular property or process are to be fairly allocated. The net effect of these requirements is to require in the computation of net income of the taxpayer from the property a deduction for almost every item which would be deductible in computing net taxable income from the property except depletion. For example, interest on borrowed money and amounts paid in settlement of silicosis claims are deductible but contributions to charity are not required to be deducted if they are not attributable directly to the mineral property.

Property is defined as the interest owned by the taxpayer in any mineral property, but in the event the taxpayer has interest in separate mineral properties, each interest is a separate property. Where two or more mineral properties are included in a single tract or parcel of land, the taxpayer's interest may be considered a single property, provided such treatment is consistently followed. This definition has caused confusion because one mine may involve two leases or may involve a combination of a fee interest and a lease interest; and for the purpose of percentage depletion, the Commissioner may require these interests to be treated as separate properties, causing difficult problems of allocation.

To illustrate the application of percentage depletion, the example in the discussion of cost depletion may be used. In that example the taxpayer produced and sold 50,000 tons of iron ore with, let it be assumed, an f.o.b. mine value of $5 per ton. No royalty payments are involved because the taxpayer owns the fee of the land and, therefore, his gross income from the property would be $250,000 and 15 per cent of the gross income amounts to $37,500. If it is assumed that the net income of the taxpayer from the property, without allowance for depletion, amounts to $1 per ton, 50 per cent of the net income on 50,000 tons would amount to $25,000 and the percentage depletion allowable would thus be governed by 50 per cent of the net income and would be in the amount of $25,000. In this particular example, the excess of percentage depletion over cost depletion amounts to $10,000. The taxpayer would be entitled to a total depletion deduction of $25,000, and he would adjust his basis for the property by this amount, i.e. it would be reduced to $575,000 for the purpose of calculating cost depletion in the next year. As soon as the basis is fully recovered, the taxpayer will no longer be entitled to cost depletion but may still obtain percentage depletion.

Conclusion

This discussion has touched in a broad way some of the problems involving depletion. In using the term depletion, its meaning from an economic and geological viewpoint and its meaning from a Federal Income Tax viewpoint must be distinguished. Depletion from the tax viewpoint refers to a statutory deduction allowable in computing the taxable income of a mining enterprise. Every Revenue Act since 1913 has contained provisions relating to the amount and method of calculating the allowance for depletion. A metal mine taxpayer who otherwise meets the eligibility requirements is entitled to an allowance for depletion computed by the cost method or by the percentage method, whichever is higher. The determination of the depletion deduction by these methods is largely a mechanical process once the basic factors are established.

The mining industry differs from other industries because the mineral producer is really engaged in two interrelated activities. One activity involves the rendition of the services of mining and processing of minerals to produce a marketable product, and, in this respect, the mining industry is comparable to many other industries. The second activity, however, distinguishes the mining industry because it involves the sale of the mineral producer's supply of mineral. This supply of mineral is the basic capital asset of any mining enterprise, and the production and sale of the mineral ultimately involves the liquidation of the enterprise unless new deposits are discovered and developed. The discovery of new deposits in turn involves the expenditure of large sums of money for exploration, and it is well known that for every successful exploration there are many, many failures. The depletion provisions of the Code are intended to eliminate what would otherwise be an inequity because they recognize that capital should not be taxed as income. Also, these provisions, while in need of some changes to encourage and accelerate exploration and development, do assist in stimulating new risk capital to enter into the mining field and provide a method whereby existing mining enterprises may set aside funds for further exploration.

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Hayward Co.
50 Church Street, New York 7, N. Y.
Orange Peel Buckets, Clam Shell Buckets, Electric Motor Buckets, Automatic Take-up Reels

Heidenreich, E. Lee, Jr., Consulting Engineers
67 Second St., Newburgh, N. Y.
Plant Layout, Design, Supervision; Open Pit Quarry Surveys; Appraisals—Plant and Property

Hendrick Mfg. Co.
Carbondale, Pa.
Perforated Metal Screens, Perforated Plates for Vibrating, Shaking, and Revolving Screens; Elevator Buckets; Test Screens; Wedge Slot Screens; Open Steel Floor Grating

Hercules Powder Co.
Wilmington 99, Del.
Explosives and Blasting Supplies

Hetherington & Berner Inc.
701-745 Kentucky Ave., Indianapolis 7, Ind.
Asphalt Paving Machinery, Sand and Stone Dryers, Dust Collectors

Hewitt-Robins Incorporated
370 Lexington Ave., New York 17, N. Y.
Belt Conveyors (Belting and Machinery); Belt and Bucket Elevators; Car Shake-outs; Feeders; Industrial Hose; Screen Cloth; Sectional Conveyors; Skip Hoists; Stackers; Transmission Belting; Vibrating Conveyors, Feeders, and Screens; Design and Construction of Complete Plants

Illinois Powder Mfg. Co.
112 N. Fourth St., St. Louis 2, Mo.
Gold Medal Explosives

Ingersoll-Rand Co.
11 Broadway, New York 4, N. Y.
Rock Drills, Quarrymaster Drills, Jackbits, Bit Reconditioning Equipment, Portable and Stationery Air Compressors, Air Hoists, Slusher Hoists, Air Tools, Diesel Engines, Pumps

Insley Manufacturing Corp.
801 N. Olney St., Indianapolis 6, Ind.
Concrete Carts and Buckets, ½ Yd. Cranes and Shovels

Iowa Manufacturing Co.
916 16th St., N.E., Cedar Rapids, Iowa
Rock and Gravel Crushing, Screening, Conveying and Washing Plants, Hot and Cold Mix Asphalt Plants, Stabilizer Plants, KU-BIT Impact Breakers, Screens, Elevators, Conveyors, Portable and Stationary Equipment, Hammermills

Jaeger Machine Co.
550 W. Spring St., Columbus 16, Ohio
Portable and Stationary Air Compressors, Self-Priming Pumps, Truck Mixers, Concrete Mixers, Road Paving Machinery, Hoists and Towers

Jaite Co.
Jaite, Ohio
Multiwall Paper Bags, Sewn and Pasted Style for Packaging Lime, Cement, Plaster, Etc.

Jeffrey Manufacturing Co.
E. First Ave., Columbus 16, Ohio
Material Handling Machinery, Crushers, Pulverizers, Screens, Chains

Johnson-March Corp.
1724 Chestnut St., Philadelphia 3, Pa.
Dust Allaying Equipment

Joy Manufacturing Co.
333 Henry W. Oliver Bldg., Pittsburgh 22, Pa.
Drills: Blast-Hole, Wagon, Rock, and Core; Air Compressors: Portable, Stationary, and Semi-Portable; Aftercoolers; Portable Blowers; Carpullers; Hoists; Multi-Purpose and Portable Rock Loaders; Air Motors; Trench Diggers; Belt Conveyors; Drill-Bit Furnaces; "Spaders"; "String-a-Lite" (Safety-Lighting-Cable); Backfill Tampers; Drill Bits: Rock and Core

Kennedy-Van Saun Mfg. and Eng. Corp.
2 Park Ave., New York 16, N. Y.
Crushing, Screening, Washing, Conveying, Elevating, Grinding, Complete Cement Plants, Complete Lime Plants, Complete Lightweight Aggregate Plants, Synchronous Motors, Air Activated Containers for Transportation of Pulverized Material, Cement Pumps, and Power Plant Equipment

Kensington Steel Co.
505 Kensington Ave., Chicago 28, Ill.
Manganese Steel Castings, Dipper Teeth, Crawler Treads, Jaw Plates, Concaves and Hammers

Keystone Driller Co.
2001-2021 Eighth Ave., Beaver Falls, Pa.
Drills, Power Shovels

King Powder Co., Inc.
Cincinnati, Ohio
Detonite, Dynamites, and Blasting Supplies

Manufacturers Division—National Crushed Stone Association

(continued)

Koehring Co.
3026 W. Concordia Ave., Milwaukee 16, Wis.
Excavating, Hauling and Concrete Equipment

Kraft Bag Corp.
630 Fifth Ave., New York 20, N. Y.
Heavy Duty Multiwall Paper Bags

Link-Belt Co.
300 West Pershing Road, Chicago 9, Ill.
Complete Stone Preparation Plants; Conveyors, Elevators, Screens, Washing Equipment, Speed-O-Matic Shovels—Cranes—Draglines and Power Transmission Equipment

Ludlow-Saylor Wire Co.
634 S. Newstead Ave., St. Louis 10, Mo.
Woven Wire Screens and Wire Cloth of Super-Loy, All Commercial Alloys and Metals

Mack Manufacturing Corp.
350 Fifth Ave., New York 1, N. Y.
On- and Off-Highway Trucks, Tractor Trailers, Six-Wheelers, from 5 to 30 Tons Capacity, both Gasoline- and Diesel-Powered

Marion Power Shovel Co.
617 W. Center St., Marion, Ohio
A Complete Line of Power Shovels, Draglines, and Cranes

Marsh, E. F., Engineering Co.
4324 W. Clayton Ave., St. Louis 10, Mo.
Plant Design, Engineering Service, Complete Pit and Quarry Equipment

McLanahan & Stone Corp.
200 Wall St., Hollidaysburg, Pa.
Complete Pit, Mine, and Quarry Equipment —Crushers, Washers, Screens, Feeders, etc.

Michigan Power Shovel Co.
270 Miller St., Benton Harbor, Mich.
Truck Mounted and Crawler Shovel Crane 3/8 and 1/2 Cu. Yd.

Murphy Diesel Co.
5317 W. Burnham St., Milwaukee 14, Wis.
Murphy Diesel Engines Ranging from 90 to 190 Continuous Horsepower at 1200 Rpm. and Packaged Type Generator Sets 60 to 133 Kw. for All Classes of Service

Nelson, N. P., Iron Works, Inc.
820 Bloomfield Ave., Clifton, N. J.
Nelson Bucket Loaders

Nordberg Mfg. Co.
3073 S. Chase Ave., Milwaukee 7, Wis.
Cone, Gyratory, Jaw and Impact Crushers; Grinding Mills; Stone Plant and Cement Mill Machinery; Vibrating Screens; Grizzlies; Diesel and Steam Engines; Compressors; Mine Hoists; Track Maintenance Tools

Northern Blower Co.
6409 Barberton Ave., Cleveland 2, Ohio
Dust Collecting Systems, Fans—Exhaust and Blower

Northwest Engineering Co.
135 S. LaSalle St., Chicago 3, Ill.
Shovels, Cranes, Draglines, Pullshovels

Osgood Co.
Cheney Ave., Marion, Ohio
Power Shovels, Cranes, Draglines, Hoes, Etc., 3/8 to 2 1/2 Cu. Yd.

Pennsylvania Crusher Co.
Liberty Trust Bldg., Broad and Arch Sts., Philadelphia 7, Pa.
Single Roll Crushers, Impactors, Hammermills, Ring Type Granulators, KUE-KEN Jaw Crushers, KUE-KEN Gyracones, Dixie Non-Clog and Standard Hammermills

Pettibone Mulliken Corp.
4710 W. Division St., Chicago 51, Ill.
Buckets, Dragline and Parts; Loaders—Car, Bucket; Plants—Asphalt, Portable

Pioneer Engineering Works, Inc.
1515 Central Ave., N. E., Minneapolis 13, Minn.
Jaw Crushers, Roll Crushers (Twin and Triple), Vibrating and Revolving Screens, Feeders (Mechanical, Grizzly, Apron, and Pioneer-Oro), Belt Conveyors, Portable and Stationary Crushing and Screening Plants, Washing Plants, Mining Equipment, Cement and Lime Equipment, Asphalt Plants

Pit and Quarry Publications
538 South Clark St., Chicago 5, Ill.
Pit and Quarry, Pit and Quarry Handbook, Pit and Quarry Directory, Concrete Manufacturer, Concrete Industries Yearbook

Quaker Rubber Corp.
Tacony and Milnor Sts., Philadelphia 24, Pa.
Conveyor Belts, Hose, and Packings

Rock Bit Sales and Service Co.
350 Depot St., Asheville, N. C.
Tungsten Carbide Detachable Bits, "Rock Bit" Drill Steel Inlaid with Tungsten Carbide, Carbon Hollow Drill Steel, Alloy Hollow Drill Steel

Manufacturers Division—National Crushed Stone Association
(concluded)

Rock Products
309 West Jackson Blvd., Chicago 6, Ill.

Roebling's, John A., Sons Co.
Woven Wire Fabrics Division
Roebling, N. J.
Aggregate Screen, Hardware and Industrial Wire Cloth, Insect Screening, Wire Rope, Fittings and Strand, Slings, Suspension Bridges and Cables, Aerial Wire Rope Systems, Ski Lifts, Electric Wire and Cable, Magnet Wire

Sanderson-Cyclone Drill Co.
South Main St., Orrville, Ohio
All Steel Wire Line, Air Speed Spudders, Large Blast Hole Drills, Drilling Tools and Drilling Supplies

Schield Bantam Co.
Waverly, Iowa
Bantam Trench Hoes, Draglines, Clams, Shovels

Screen Equipment Co.
1754 Walden Ave., Buffalo 21, N. Y.
SECO Vibrating Screens

Shaped Charge Explosive Manufacturers, Inc.
P. O. Box 900, Martinsburg, W. Va.
Shaped Charge Explosives for Industrial Rock Reduction

Simplicity Engineering Co.
Durand, Mich.
Simplicity Gyrating Screen, Simplicity D'centegrator, Simplicity D'watering Wheel

Smith Engineering Works
532 E. Capitol Drive, Milwaukee 12, Wis.
Gyratory, Gyrasphere, Jaw and Roll Crushers, Vibrating and Rotary Screens, Gravel Washing and Sand Settling Equipment, Elevators and Conveyors, Feeders, Bin Gates, and Portable Crushing and Screening Plants

Stedman Foundry & Machine Works
Aurora, Ind.
Stedman Impact-Type Selective Reduction Crushers, 2-Stage Swing Hammer Limestone Pulverizers

Stephens-Adamson Mfg. Co.
Aurora, Ill.
Belt Conveyors, Elevators, Feeders, Car Pullers, Screens, Skip Hoists, Complete Plants

Talcott, W. O. & M. W., Inc.
91 Sabin St., Providence 1, R. I.
Belt Fasteners, Belt Lacing, Conveyor Belt Fasteners, and Patch Fasteners

Taylor-Wharton Iron & Steel Co.
High Bridge, N. J.
Manganese and other Special Alloy Steel Castings; Dipper Teeth, Fronts and Lips; Crawler Treads; Jaw and Cheek Plates; Mantles and Concaves; Pulverizer Hammers and Liners; Asphalt Mixer Liners and Tips; Manganese Nickel Steel Welding Rod and Plate

Thew Shovel Co.
East 28th St. and Fulton Rd., Lorain, Ohio
Power Shovels, Cranes, Crawler Cranes, Locomotive Cranes, Draglines, Diesel Electric, Gasoline, 3/8 to 2 1/2 Cu. Yd. Capacities

Torrington Co.
Bantam Bearings Division
3702 W. Sample St., South Bend 21, Ind.
Anti-Fricition Bearings; Roller Bearings: Spherical, Tapered, Straight, Ball, Needle

Traylor Engineering & Mfg. Co.
Allentown, Pa.
Stone Crushing, Gravel, Lime, and Cement Machinery

Trojan Powder Co.
17 N. 7th St., Allentown, Pa.
Explosives and Blasting Supplies

Tyler, W. S., Co.
3615 Superior Ave., N. E., Cleveland 14, Ohio
Woven Wire Screens; Ty-Rock, Tyler-Niagara and Ty-Rocket (Mechanically Vibrated) Screens; Hum-mer Electric Screens; Ro-Tap Testing Sieve Shakers and Tyler Standard Screen Scale Sieves

Universal Engineering Corp.
625 C Ave., N. W., Cedar Rapids, Iowa.
Jaw Crushers, Roll Crushers, Hammermills, Complete Crushing, Screening, and Loading Plants, Either Stationary or Portable for Stone Aggregates or Aglime

Vibration Measurement Engineers
7705 Sheridan Rd., Chicago 26, Ill.
Specialists in Blasting Complaint Investigations; Seismological Surveying; Expert Testimony in Blasting Litigation